

National Aeronautics and
Space Administration



EXPLORE MOON *to* MARS

Moon to Mars Update

Dr. David Burns

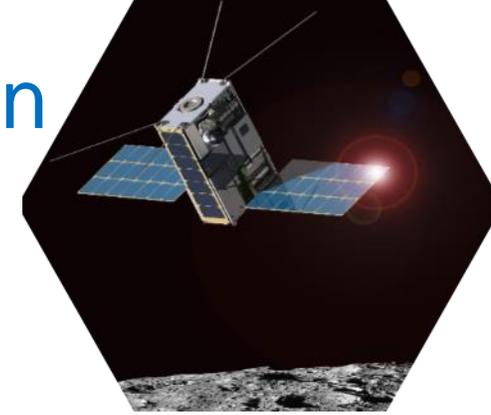
Acting Deputy Associate Administrator for Exploration
Science Mission Directorate, NASA

January 2021





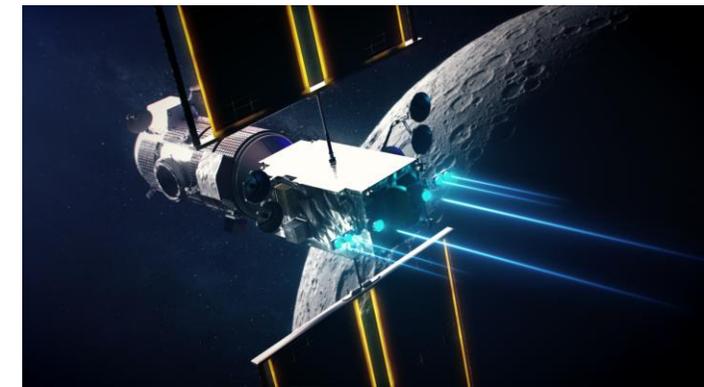
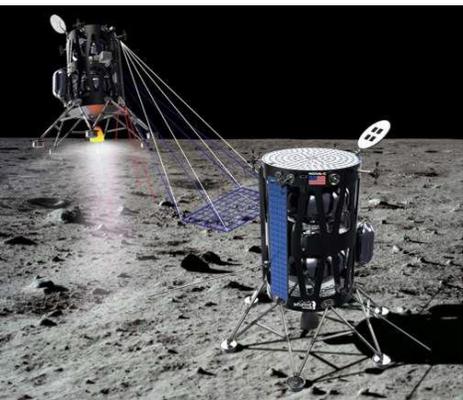
Exploration Science Strategy and Integration Office (ESSIO) formulates & executes an *integrated strategy* for exploration science



Implementation Strategy

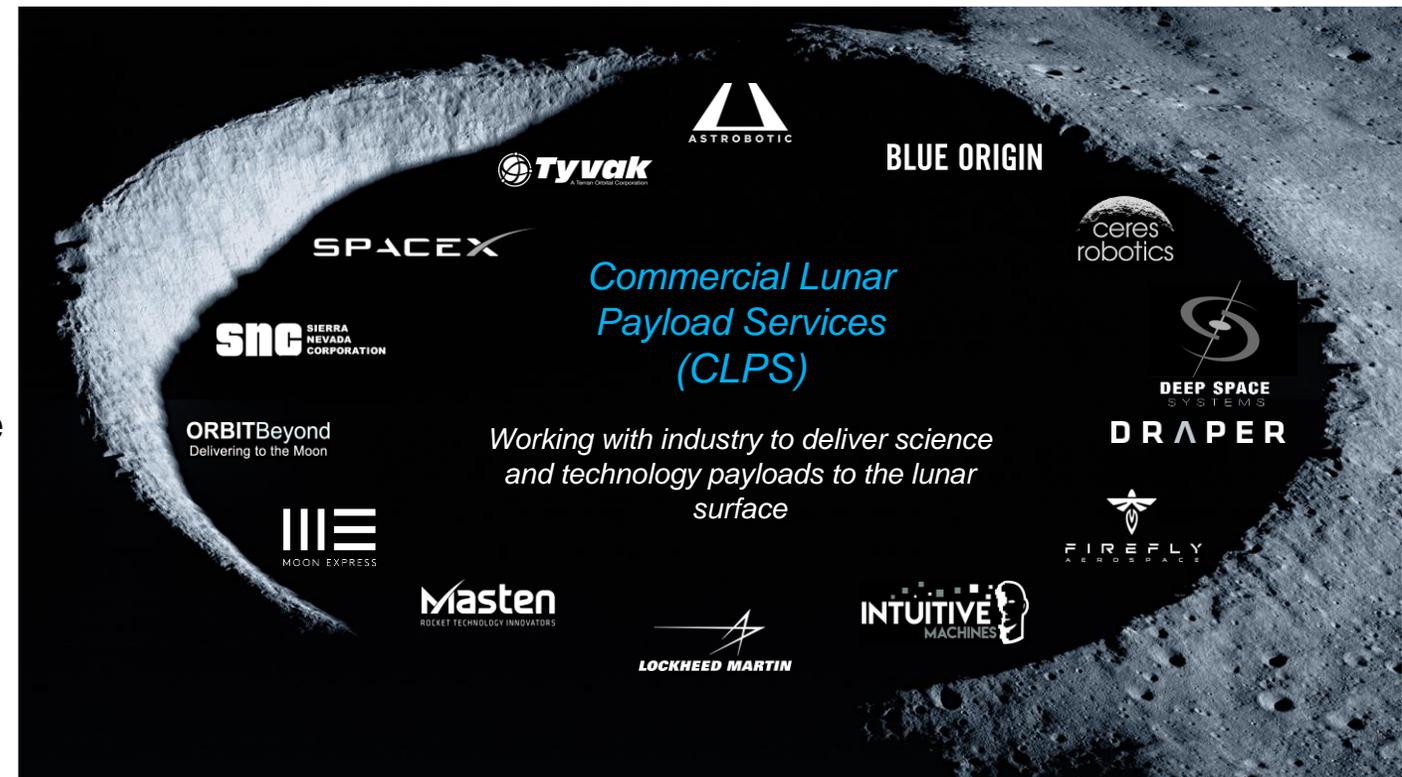
- Develop lunar surface science instruments
- Use commercial companies to deliver payloads to the Moon
- Develop mobility systems to expand and enhance science investigations on the surface
- Leverage international partnerships for additional opportunities (e.g., instruments, rovers)
- Obtain new scientific data from lunar orbit using smallsats
- Use new human exploration systems, such as Gateway and human landing systems, to enable science
- Lead the science mission planning for humans on the lunar surface

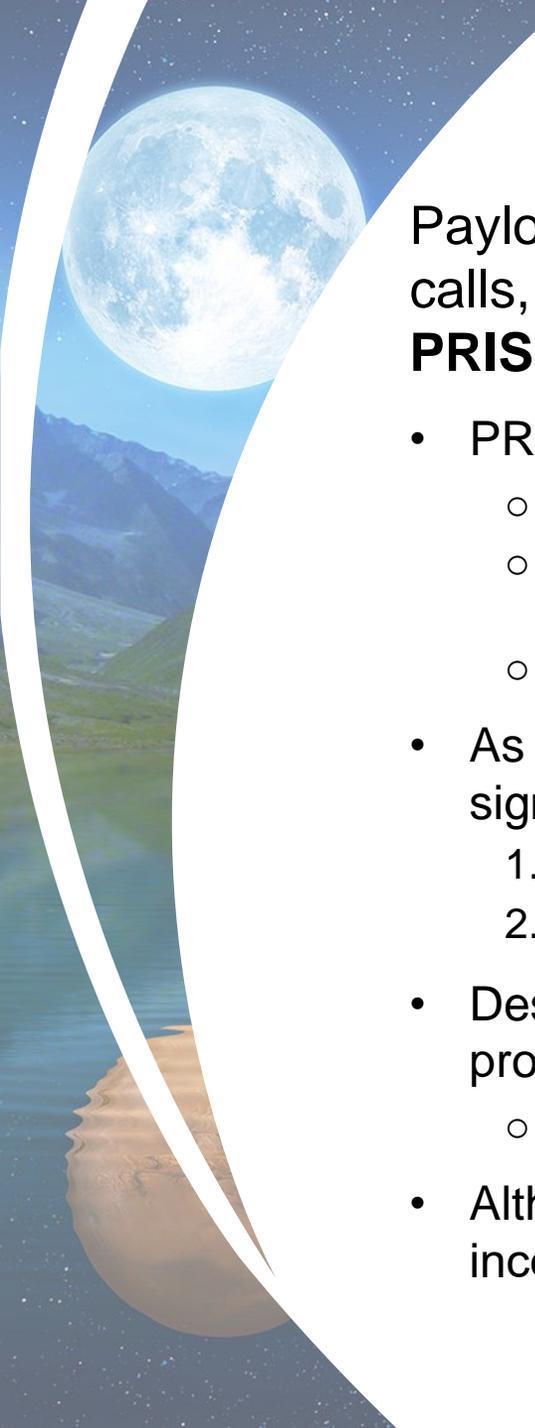
Lunar
Discovery &
Exploration
Program
(LDEP)



Commercial Lunar Payload Services (CLPS)

- **Goal: Utilize commercial end-to-end delivery services to enable access to the lunar surface**
- Deliveries initiated using a Task Order
 - Any of the 14 companies on the catalog can respond to a task order
 - Expected Task Order cadence of 2 per year
- Task order lists what NASA wants delivered, and any constraints
 - E.g., landing site, specific needs of instruments
- First 4 lunar surface delivery task orders awarded with deliveries commencing in 2021
 - 2021: Non-polar delivery (Astrobotic and Intuitive Machines) – TO 2A & 2B
 - 2022: Polar delivery (Masten) – TO 19C
 - 2022: PRIME-1 (Intuitive Machines)
 - 2023: Volatiles Investigating Polar Exploration Rover (VIPER) to Moon's south polar region (Astrobotic) – TO 20A





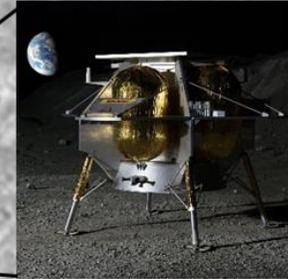
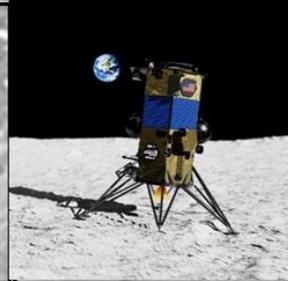
CLPS Deliveries & Future Payloads

Payloads for early CLPS deliveries from NPLP (NASA internal) and LSITP (external) calls, were focused on speed. Now we are working towards a science-driven model via **PRISM (Payloads and Research Investigations for the Surface of the Moon)**.

- PRISM calls occur at a regular cadence
 - PRISM instruments feed manifests for deliveries from late 2023 onwards
 - First PRISM call requests science investigations utilizing multi-instrument suites to maximize the science for named locations
 - High-value 'location agnostic' instruments may be called for in PRISM-2
- As discussed in community documents, the locations are high science-value targets where significant progress can be made utilizing CLPS platforms; the locations for this call are:
 1. Reiner Gamma magnetic anomaly (lunar swirl)
 2. Schödinger farside basin impact melt
- Destinations for these two deliveries were announced in July, allowing PIs ample time to propose science optimized for those locations
 - Step 1 proposals received in December, and step 2 proposals due Feb 3
- Although PRISM call focuses on science payloads, other Mission Directorate payloads can be incorporated into Task Orders through the 'CLPS payload ingest process'

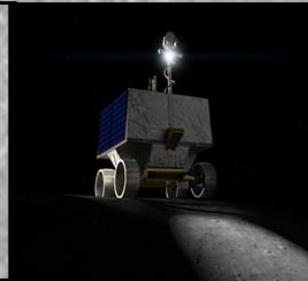
CLPS Deliveries 2021-2024

Delivery Site:
Oceanus Procellarum
Provider:
Intuitive Machines
Task Order (TO) 2 | 2021



Delivery Site:
Lacus Mortis
Provider:
Astrobotic
TO2 | 2021

Delivery Site:
Lunar Pole
Provider:
Astrobotic
VIPER | 2023

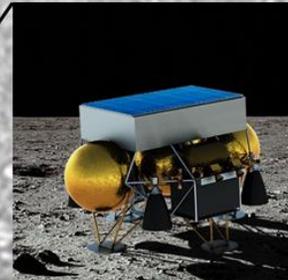
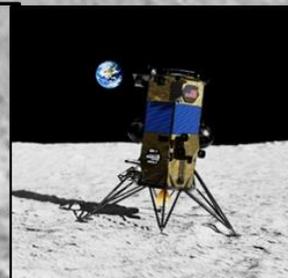


Delivery Site:
Reiner Gamma
Provider: TBD
PRISM-1a | 2023

Delivery Site:
Mare Crisium
Provider: TBD
TO19D | 2023

Delivery Site:
Schrödinger Basin
Provider: TBD
PRISM-1b | 2024

Delivery Site:
South Pole
Provider:
Intuitive Machines
TO PRIME-1 | 2022



Delivery Site:
South Pole
Provider:
Masten
TO19C | 2022

TO2 – ASTROBOTIC TECHNOLOGY

July 2021 Launch



TO2 – INTUITIVE MACHINES

October 2021 Launch



2021 CLPS Delivery Manifests

Payloads largely selected from
NASA Provided Lunar Payloads (NPLP)

Astrobotic

Surface Exosphere
Alterations by
Landers (SEAL)

Photovoltaic
Investigation on
Lunar Surface (PILS)

Near-Infrared
Volatile
Spectrometer
System (NIRVSS)

Mass Spectrometer
Observing Lunar
Operations (Msolo)

PROSPECT Ion-Trap
Mass Spectrometer
for Lunar Surface
Volatiles (PITMS)

Linear Energy
Transfer
Spectrometer
(LETS)

Neutron
Spectrometer
System (NSS)

Neutron
Measurements
at the Lunar
Surface (NMLS)

Fluxgate
Magnetometer
(MAG)

Navigation
Doppler Lidar
for Precise
Velocity and
Range Sensing
(NDL)

Key

Science	
Technology	
Exploration	
HEOMD/STMD	

Intuitive Machines

Lunar Node 1
Navigation
Demonstrator (LN-1)

Stereo Cameras for
Lunar Plume-Surface
Studies (SCALPSS)

Low-frequency Radio
Observations from the
Near Side Lunar
Surface (ROLSSES)

Navigation Doppler
Lidar for Precise
Velocity and Range
Sensing (NDL)

Radio Frequency Mass
Gauge (RFMG)



The Moon Enables Scientific Exploration

A CORNERSTONE

For Solar System science and exoplanet studies

A TRAINING GROUND

To learn how to conduct scientific exploration from a planetary surface, working synergistically with crew and robotic explorers

A NATURAL LABORATORY

To study planetary processes and evolution

AN OPPORTUNITY

To use infrastructure and resources associated with human exploration to leverage support for autonomous scientific investigations